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Driveway-related Crashes

Much of access management involves managing traffic movements into and out of commercial driveways. The reason for this is that driveway traffic generates a large number of crashes on major roads and streets—arterials and collectors.

What types of accidents occur at commercial driveways?
Several research studies have been conducted on the nature of traffic accidents that occur at driveways. In particular, three multiyear studies of hundreds of crashes at more than 1,300 driveways in three different communities in Illinois found the following range of crash involvement at commercial driveways:

Turning Movement	Percent of Total Crashes at Commercial Driveways
Left-turning vehicles:	
Entering business driveways	43% to 78%
Exiting business driveways	14% to 31%
Right-turning vehicles:	
Entering business driveways	6% to 15%
Exiting business driveways	2% to 15%

Source: Paul Box and Associates, 1998.

Why is this important?
Although the results from Illinois varied widely by community, two main conclusions can be drawn:

1. Left-turning vehicles (exiting and entering) are involved in the majority of driveway-related crashes.
2. The movement responsible for more than 40 percent of all the crashes at a commercial driveway involves entering vehicles turning left.

The Douglas Avenue/Euclid Avenue corridor, which is a main east-west arterial route through the Des Moines, Iowa, metropolitan area provides a good illustration (see photographs). The level of access management varies significantly throughout this corridor. Where access is well managed, such as in the city of Urbandale or in Des Moines just east and west of Interstate 235, there are very few left-turn-related crashes. In areas where no left turns are permitted, there are, naturally, no left-turn-related crashes. On the other hand, along sections where there is little access management (no medians or turning lanes and a high number of driveways per mile) there is a high incidence of left-turn crashes.

Section of unmanaged access along the Douglas Avenue/Euclid Avenue corridor in Des Moines, Iowa. Result: a high incidence of left-turn crashes.

Section of managed access along the Douglas Avenue/Euclid Avenue corridor in Des Moines, Iowa. Result: very few left-turn-related crashes.

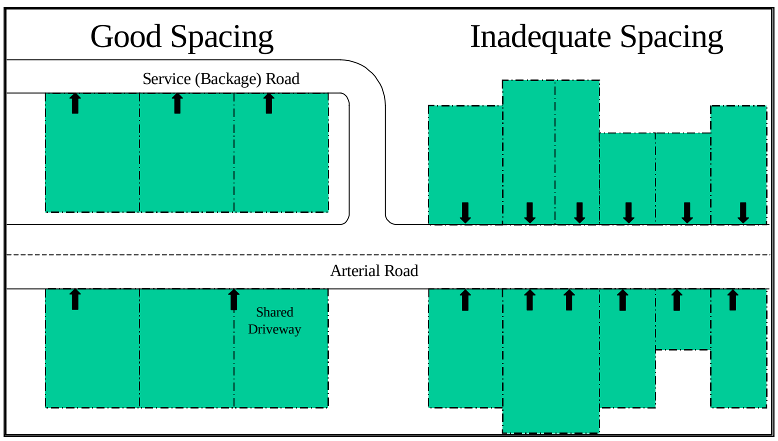
Developing and designing strategies and projects to accommodate and/or manage left-turning vehicles needs to be a main concern in managing access on arterial street corridors.

What do statistics about driveway accidents mean for access management projects?
These conclusions show why access management projects that effectively provide for, manage, or even eliminate left turns are so effective. Successful access management projects usually include such measures as driveway consolidation, two-way-left-turn lanes, dedicated right-turn lanes, and raised medians. Projects or designs that combine two or more means of managing left turns are usually very effective in increasing traffic safety. On the other hand, roads where left turns are not effectively managed may have relatively high crash rates.

Driveway Spacing

Maintaining an adequate spacing between commercial driveways is one of the most critical aspects of access management.

Why is driveway spacing important?
Motorists turn left and right into and out of driveways when permitted. Traffic turning into and out of driveways moves more slowly than through traffic. This speed difference produces conflicts that may lead to broadside and rear-end collisions between vehicles. Traffic safety research commissioned by the Minnesota Department of Transportation shows that roadways with a large number of closely spaced driveways are *always* less safe than similar roads where driveway access is more limited. For example, an urban route with 100 feet between driveways should experience roughly twice as many accidents as a route with similar turning and through volumes with 250 feet between drives.



Good spacing is achieved with driveway spacing requirements, shared driveways, limits on the number of driveways per lot, and deep lots accessed by service roads. Deep lots also allow space for a buffer between developments and the arterial and off-street parking.

What's a reasonable distance between commercial driveways in urban/suburban areas?
Spacing requirements may be based, among other factors, on posted speed limits, the classification of the roadway, or the amount of traffic generated by a development. Spacing requirements should reflect a balance between traffic and engineering conditions and needs, local development objectives, and existing land-use characteristics (such as lot sizes, land-use type, and frontage requirements).

There are no hard and fast guidelines for driveway spacing, and spacing requirements vary considerably from place to place. However, the table below is used by two local governments in Florida and Ohio and is indicative of good practice. As the posted speed limit rises, the recommended spacing between driveways increases and the number of driveways per mile or block falls to accommodate the increased spacing.

Posted Speed on Arterial Street (mph)	Centerline to Centerline Driveway Spacing (feet)	Approx. Number of Driveways per 500-foot Block Face
20	85	About 6
25	105	5
30	125	4
35	150	3
40	185	3
45	230	2
50	275	Fewer than 2

Source: City of Tallahassee, Florida, and OKI Regional Government, Cincinnati, Ohio.

These guidelines are based on the minimum distance needed to reduce collision potential due to overlapping right turns. Since urban and suburban arterials typically are designed to operate at 35 to 45 miles per hour, the desirable minimum driveway spacing will be approximately 150 to 230 feet, allowing for only 2 to 3 driveways per block face. When this range of spacing is not achieved, the result will be a higher traffic accident rate.

What about in rural areas?

In rural areas, the posted speed is usually at or above 55 miles per hour. The higher speeds mean that driveway spacing in rural areas must be longer to provide for a safe driving environment. On state highways, spacing is also longer because the routes are primarily designed to carry through traffic rather than to serve as property access routes. Most states use a hierarchy to apply a driveway spacing standard. The more important a route is to through traffic and commerce, the longer the spacing between driveways. The following table shows Kansas's standards for its highway system.

State Highway Route Type	Minimum Spacing between Driveways (feet)	Approx. Number of Driveways per Mile
Major arterial (National Highway System)	2,640	2
Other major arterial	1,320	4
Minor arterial	660	8
Other (collector, etc.)	500	10

Source: Kansas Department of Transportation.

On county roads, the spacing standard should also depend on the nature of the road (e.g., how important the road is to through traffic). Even the lowest functional levels require driveway spacing standards for traffic safety, as shown in the following table from a county in Wisconsin.

County Road Route Type	Minimum Spacing between Driveways (feet)	Number of Driveways per Mile
Minor arterials	600	9
Collectors	300	18
Local traffic service	75	70

Source: Waushara County, Wisconsin.

Driveway Density and Driveway Consolidation

Driveway density (the number of driveways per block or per mile) and driveway consolidation are very important considerations in access management. These roadway characteristics are basic issues in any access management plan or program.

Why is driveway density important?
Driveway density is important because accident rates increase dramatically as the number of driveways per mile increases along urban arterial roadways (see table below).

Driveways per Mile	Approx. Number of Driveways per 500-foot City Block	Representative Accident Rate for a Multilane, Undivided Roadway	Increase in Accidents Associated with Higher Driveway Density
Under 20	Under 2	3.4	—
20 to 40	2 to 4	5.9	+74%
40 to 60	4 to 6	7.4	+118%
Over 60	Over 6	9.2	+171%

Source: National Cooperative Highway Research Program Report 3-52.

Note that, although 500 feet might be a typical city block length, block lengths vary from place to place. Some older neighborhoods have 400- to 500-foot blocks. Some newer communities use much longer blocks. A common block face in suburban areas is 660 feet (which provides eight city blocks per mile).

What is a reasonable driveway density for urban/suburban areas?
Different states and localities have adopted various driveway density standards for urban and suburban arterial streets. However, many of them recommend 20 to 30 driveways per mile as a maximum driveway density standard. Above this level, accident rates become unacceptably high. This standard applies to commercial driveways on urban, multilane arterials with a posted speed limit of 35 miles per hour. This translates into a desired standard of only two or three driveways per 500-foot city block face.

The Institute of Transportation Engineers (ITE) recommends a maximum number of driveways per commercial property that yields a driveway density similar to those described above. Exceptions to these standards may be required if property ownership is very fragmented and property lot frontages are very short. A potential solution in such cases is shared driveways. ITE's recommendations are presented in the following table.

Property Frontage (feet)	Number of Driveways
0 to 50	1
50 to 165	2
165 to 500	3
Over 500	4

Source: ITE Guidelines for Driveway Location and Design, 1987.

Some states, Kansas for instance, have set minimum property frontage standards for a commercial driveway permit. Along urban arterials, Kansas only allows driveway access on properties with at least 60 feet of frontage.

Driveway densities should be even lower if the posted speed limit is higher or if the roadway is functionally important to through traffic, such as highways designated as part of the National Highway System (NHS) or the Iowa Commercial and Industrial Network (CIN). Driveway densities can safely be higher if they serve residential properties. This is because residences generate far fewer trips per hour than commercial or industrial properties. However, driveways should *never* be located on or close to corners of intersections. They should also never be located within the functional area of an intersection (e.g., along right-turn lanes provided at intersections).

What about in rural areas?
Spacing between driveways and/or farm-field entrances is especially critical in rural areas because travel speeds are high. Higher vehicle speeds mean that driver reaction and stopping distances are longer. In rural areas, a maximum driveway density standard of about four access points per mile per roadway side is appropriate on many arterial roads. (This assumes that driveways on opposite sites of the road are lined up.) However, where stopping sight distances are restricted by curves or hilly terrain, this figure should be lower. It should also be lower on routes of high functional importance, such as NHS or CIN routes.

What is driveway consolidation and why is it important?
Driveway consolidation is the process of reducing the density of driveways along a major roadway by closing driveways, creating alternative access ways, creating shared driveways, relocating entrances to side streets, or promoting cross access. Such projects are generally done to improve highway safety but can also improve traffic flow. Driveway consolidation can be applied as an individual access management strategy, but it is most often done in conjunction with the installation of medians, two-way-left-turn lanes, and/or frontage or backage roads.

A 1992 access management project completed along US 34 in Fairfield, Iowa, showed that simple driveway consolidation can have a dramatic effect on traffic safety. The project closed, relocated, or consolidated eight driveways along a half-mile segment of US 34. After the project, the accident rate fell approximately 38 percent. Rear-end and right-angle crashes declined greatly.

Intersection Spacing and Traffic Signal Spacing

Although most discussions about access management focus on the management of private driveways, proper spacing of roadway intersections is an equally important access management issue.

Why is intersection spacing important?
The importance of intersection spacing is similar to that of driveway spacing. As the number of intersections per mile increase, the opportunity for crashes increases. The existence of too many intersections per mile also increases delay and congestion. On the other hand, not providing an adequately dense street network forces motorists and pedestrians to travel farther to their destinations.

What is a reasonable distance between public road intersections?
Street systems in urban and suburban areas consist of streets with different functional classifications, roles, and traffic characteristics (see below).

Roadway Type	Main Purpose of Roadway	Approx. Average Annual Daily Traffic Volume (AADT)	Percentage of Total System Traffic Carried
Freeways	Serve high-speed through traffic	50,000 and over	More than 40%
Arterials	Serve through traffic	15,000–50,000	30%
Collectors	Feed through traffic from local streets to arterials; provide limited property access	2,000–15,000	20%
Local streets	Provide property access	100–2,000	Less than 10%

Intersection spacing along major (arterial) urban and suburban streets should follow the pattern given below. A traditional grid street system provides the ideal method to create this spacing.

Main Roadway	Intersecting Minor Roadway	Recommended Intersection Spacing
Freeway	Arterial	1 to 2 miles minimum
Arterial	Arterial	1 mile or greater
Arterial	Collector	0.5 mile or greater

Freeway intersections should be spaced no less than one mile apart in urban areas. Arterials should intersect with other arterials at no less than one-mile spacing. Collectors should intersect with arterials at not less than one-half mile spacing. The intersection of local roads with arterials is not recommended, but if required should not be less than 500 to 660 feet apart.

What sort of spacing should be maintained in rural areas?
Spacing between intersections is especially critical in rural areas because vehicle speeds are high. In rural areas, it is advisable to keep intersections between public roads at least one-half mile apart. A one-mile spacing between public road intersections is preferred.

How far apart should traffic signals be placed on an arterial?
Traffic signals are used to regulate traffic flow and preserve capacity along arterial routes. The ideal spacing for traffic signals is at least one half-mile apart (2,640 feet), which also corresponds to the preferred spacing of intersections between arterials and collectors. This represents about four to six blocks, depending on the block length. A minimum spacing of one-quarter mile (two to three blocks) should always be maintained. When the spacing between signals falls below one-quarter mile (1,320 feet), the traffic flow along the route may be disrupted. The ability of the route to carry through traffic will decrease, travel speeds may decrease, and delays and queues may develop at intersections. There is also some evidence from research that placing more than three traffic signals per mile on an arterial increases the traffic accident rate.

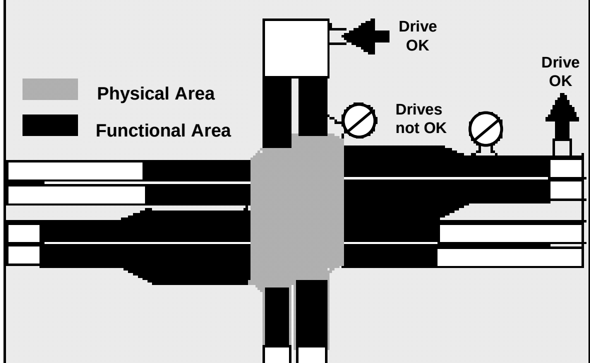
Functional Areas of Intersections

It is important to protect the functional area of an intersection from driveway access. Driveways located within this area may result in higher crash rates and increased congestion.

What is the functional area of an intersection?
The functional area of an intersection is that area beyond the physical intersection of two roadways that comprises decision and maneuvering distance, plus any required vehicle storage length. The functional area includes the length of road upstream from an oncoming intersection needed by motorists to perceive the intersection and begin maneuvers to negotiate it. The upstream area consists of distance for travel during a perception-reaction time, travel for maneuvering and deceleration, and queue storage. The functional area also includes the length of road downstream from the intersection needed to reduce conflicts between through traffic and vehicles entering and exiting a property.

Driveways should *not* be located within the functional area (see figure below).

Functional Area of Intersection



Source: Adapted from Florida Department of Transportation

The functional area includes the area beyond the physical intersection that comprises decision and maneuvering distance, plus any required vehicle storage length. For safety and operational reasons, driveways should be located outside the functional area. This area can be protected through corner clearance, driveway spacing, and intersection spacing requirements.

Why is the functional area important?
Crashes at intersections are about three times more frequent than those between intersections (*Best Practices in Arterial Management*, New York State Department of Transportation, 1996), and crash rates increase dramatically as the number of driveways per mile increases. Driveways located within the functional area create too many conflict points within too small an area for motorists to safely negotiate. In addition, corner properties typically attract businesses that generate higher volumes of traffic, such as convenience stores, gas stations, and fast food restaurants. Vehicles stopped in the travel lanes waiting to turn into a corner property may, and often do, block traffic on the roadway.

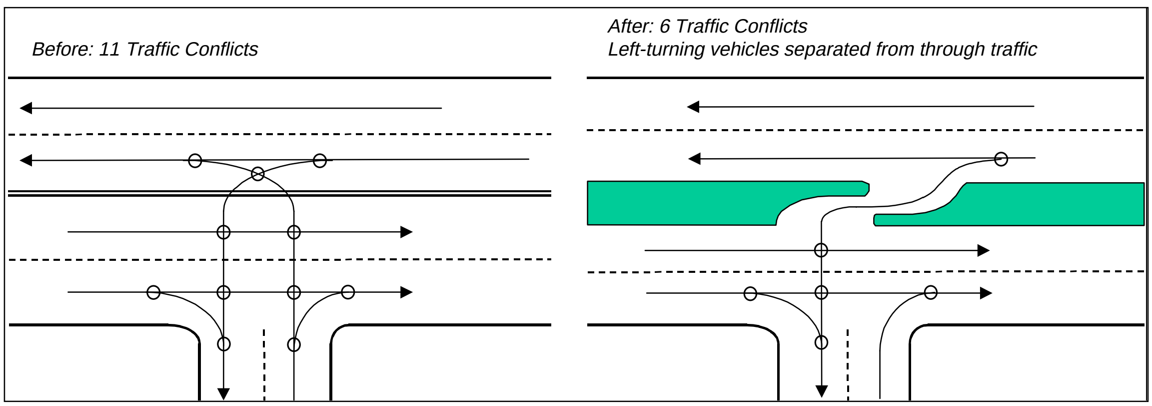
How can the functional area of intersections be protected?
The integrity of functional areas of intersections can be protected through corner clearance, driveway spacing, and intersection spacing requirements. Intersections should be spaced far enough apart so that functional areas do not overlap. This will leave room for an "access window" between intersections.

Approaches for retrofitting existing intersections include (1) consolidating driveways through shared drives and cross access, (2) providing alternative access by relocating driveways to the cross road or a frontage or backage road, and (3) installing raised medians, which eliminate left turns into and out of driveways. Median openings ("breaks") should never be located within the functional area.

Conflict Points

Conflicts points are commonly used to explain the accident potential of a roadway. Access management strategies are typically designed to reduce the number and density of conflict points.

What is a conflict point?
A conflict point is the point at which a highway user crossing, merging with, or diverging from a road or driveway conflicts with another highway user using the same road or driveway. It is any point where the paths of two through or turning vehicles diverge, merge, or cross (see figure below).



The above diagram compares traffic conflict points associated with a driveway on a four-lane undivided roadway and a driveway on a four-lane roadway with a raised median and left turn lane. The installation of the raised median with left turn lane reduces by five the number of conflict points.

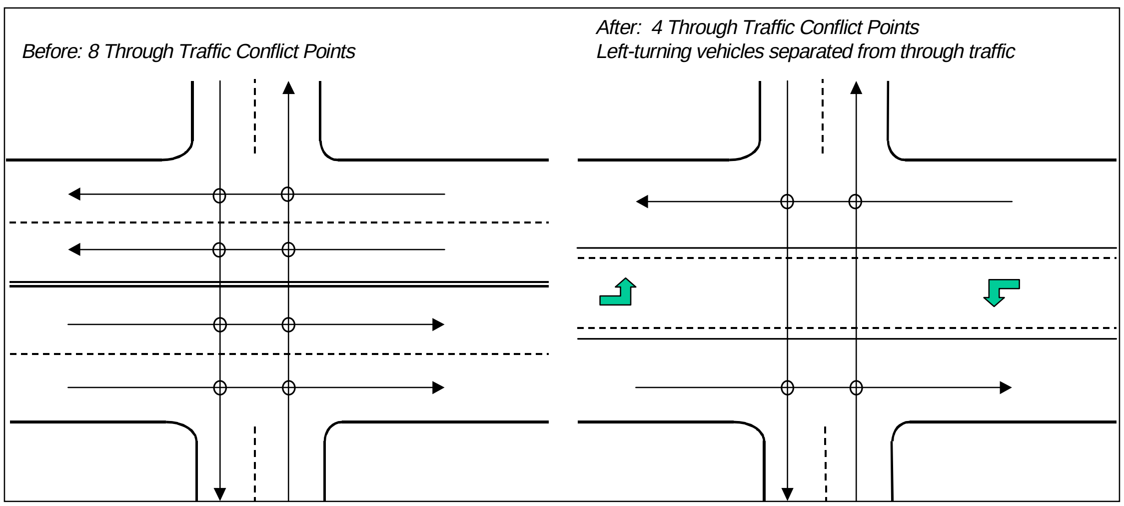
Why are conflict points important?
Conflict points are associated with increased levels of roadway accidents. A motorist can safely negotiate only so many conflict points within a given area. Studies have shown that when driveway access to arterial roadways is granted to too many property owners without considering future traffic volumes and roadway classifications, the extra driveways increase the rate of accidents and decrease the efficiency of the roadway. Although this does not appear to be a simple, direct relationship, reducing conflict points has been shown to significantly reduce the accident rate at case study locations (T. J. Simodynes, *The Effects of Reducing Conflict Points On Reducing Accident Rates*, October 1998).

Other safety-related factors include the type of conflict points that are reduced—different types of conflict points have different propensities for accidents. Studies of hundreds of crashes at more than 1,300 driveways in three different communities in Illinois found that left-turning vehicles (exiting and entering) are involved in the majority of driveway-related crashes (Paul Box and Associates, 1998).

How can conflict points be reduced by managing access?
Access management strategies can reduce traffic conflicts

- by limiting the number of conflict points that a vehicle may experience in its travel
- by separating conflict points as much as possible (if they cannot be completely eliminated)
- by removing slower turning vehicles that require access to adjacent sites from the through traffic lanes as efficiently as possible

Common strategies include relocating, consolidating, and eliminating driveways; promoting shared driveways; increasing corner clearance; improving driveway geometrics (radius, width, grade, throat length); prohibiting left turns out of driveways; installing raised medians with left turn lanes; installing two-way left turn lanes; and providing alternative access roads (such as backage roads).



Reduction in through traffic conflict points from conversion of a four-lane undivided roadway to a three-lane cross section.

Access Management Frequently Asked Questions (FAQ):

Speed Differential Between Turning Vehicles and Through Traffic

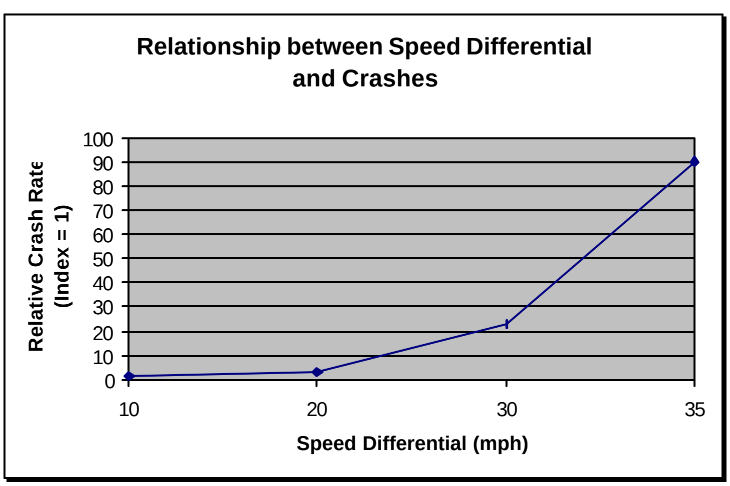
Speed differential is a simple yet important concept that forms the basis for many access management measures.

What is speed differential?
Speed differential is the difference between the speed of vehicles that are continuing along the main roadway versus those that are entering and exiting the driveway. For instance, if through traffic generally moves at 35 miles per hour and cars have to slow to 10 miles per hour to enter a driveway, the speed differential at and near that driveway is 25 miles per hour.

Why is speed differential important?
A speed differential above 20 miles per hour begins to present safety concerns. When the speed differential approaches 30 to 35 miles per hour, the likelihood of a collision between fast-moving through vehicles and turning vehicles increases very quickly. Rear-end collisions are very common on roads and streets with large driveway speed differentials and a high density of commercial driveways. When the speed differential is high, it is also more likely that crashes will be more severe, cause greater property damage, and result in more injuries and fatalities. Keeping the speed differential as low as possible is very important for safety reasons, as indicated by the table below. Many access management plans and standards strive to keep the differential at or below 20 miles per hour.

Speed Differential Between Turning and Through Traffic	Likelihood of Crashes
10 miles per hour	Minimal
20 mph	3 times greater than at 10 mph
30 mph	23 times greater than at 10 mph
35 mph	90 times greater than at 10 mph

Source: Oregon State University, 1998



What influences speeds at driveway entrances?
Speeds at driveway entrances can be influenced by a number of factors, including

- Driveway turn radius
- Driveway width
- Driveway throat length
- Driveway slope
- Existence of dedicated turn lanes
- Length of sight distance, especially for drivers exiting driveways
- Internal circulation patterns of adjoining parking lots

How can speed differentials be decreased?
In general, the following features will help decrease the speed differential between through and turning traffic:

- Larger turn radii
- Wider driveway throat widths
- Longer driveway throat lengths
- Smaller driveway slopes
- Dedicated turn lanes for both left and right turns
- Adequate sight distance at driveways
- Improved circulation within land developments

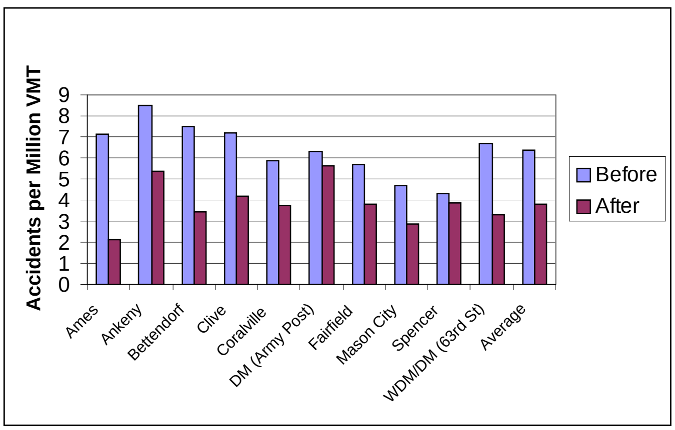
Many of these features can be easily provided if there are fewer, higher quality driveways along a roadway.

Benefits of Access Management

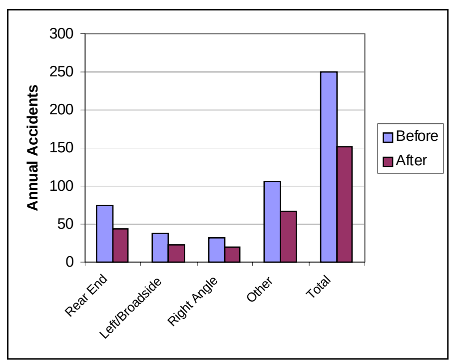
An effective, local access management program can play an important role in preserving highway capacity, reducing crashes, and avoiding or minimizing costly remedial roadway improvements. The traveling public would then benefit from faster and safer travel. The great majority of businesses would benefit from increased economic vitality along a well-managed corridor. Taxpayers would benefit from more efficient use of existing facilities. And public agencies would benefit from the relatively low cost of access management; they could then use their resources for other needs.

What are the safety benefits of access management?
Access management is a powerful tool for improving highway safety. All but two of the case studies conducted in Iowa (US 71 in Spencer and Army Post/Southwest 9th in Des Moines) led to an absolute reduction in highway crashes. All resulted in reductions in crash rates per million vehicle-miles of travel; the range of crash rate reductions was from 10 to 70 percent, with 40 percent being a typical reduction postproject. The most significant reductions occurred in terms of property-damage-only crashes, rear-end collisions, and broadside/left-turn collisions. Overall, improvements in safety tended to vary with the degree of access management applied—higher reductions in crash rates were found with the more comprehensive projects that involved a combination of access management approaches, such as those related to turn lanes, driveway management and consolidation, and medians.

Crash Reduction by City



Crash Reduction
by Type of Crash



What are the operational benefits of access management?
Each new driveway that is located on an arterial reduces the roadway's traffic-carrying capacity. After several new driveways have been installed it often becomes clear that turning traffic has a negative impact on traffic speeds on the arterial. Studies indicate that average travel speeds during peak hours are considerably higher on well managed roads than on roads that are less well managed, even though the two types of roads carry approximately the same number of vehicles. In Iowa, the series of before and after studies of access management projects found that the level of service was raised one full level during the peak traffic hour at sites studied.

Access management projects in Iowa are typically initiated on routes with moderate levels of traffic by national standards. On the case study routes in Iowa the access management projects resulted in significant increases in the ability of roads to carry traffic at levels of service to motorists that amounts to little or no congestion and delay at peak travel periods (see table).

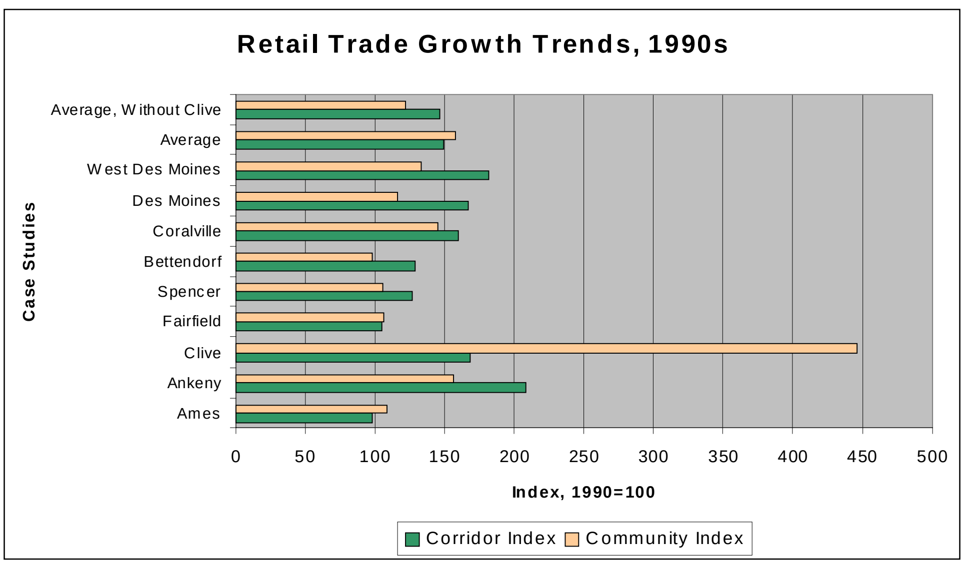
Project Location	Project Type[a]	LOS Before[b]	LOS After[b]
Ames	TWLTL	C	B
Ankeny	Median	C/D	B
Bettendorf	TWLTL	C	B
Clive	Median	D	B/C
Coralville	TWLTL	D	C
Des Moines, SE 14th	Median	D	B/C
Des Moines, Army Post/SW 9th	Median at intersection	C	C
Fairfield	Driveway	B	B
Mason City	Median at intersection	B	B
Spencer	TWLTL	B	B
West Des Moines/Des Moines	Median	B/C	A

[a]TWLTL = two-way left-turn lane.

[b]Six levels of service (LOS) describe operating conditions: A represents best conditions (uninterrupted flow and very low delay); F represents worst conditions (build-up of queues and delay); other letters identify intermediate conditions; E most often represents flow at or near capacity.

What are the economic impacts of access management?

The most compelling results (besides safety benefits) from the Iowa case studies came in terms of examining impacts on businesses and business customers along the routes. Perceived impacts of access management on adjacent commercial businesses and landowners are often major impediments to projects moving forward. The case studies showed that in fact access management projects are rather benign in terms of business impacts. Access-managed corridors generally had lower rates of business turnover than other parts of their communities. They had more rapid growth in retail sales once projects were completed. When surveyed, far more business owners indicated that their sales had been stable or increased following project completion than reported sales losses.



Most of the study corridors in Iowa show retail trade growth performance as good or better than their surrounding communities. The only notable exception found in the Iowa case studies was the city of Clive, a suburb of Des Moines. This is attributable to the explosive retail growth of newly developing areas of the city

Economic Impacts of Access Management

Business owners often are concerned that changes in access to their premises will have temporary or permanent impacts on their sales. They are concerned that changes in direct access to their property—such as consolidating driveways or installing raised medians—will lead to declines in patronage and sales. Perceived impacts of access management on adjacent commercial businesses and landowners are often major impediments to projects moving forward. In the case of access management, perceptions are often worse than reality.

What are the effects of access management on business vitality?
A business vitality study of nine different access management corridors in Iowa communities examined impacts on businesses and business customers along these routes. In general, these case studies indicated that access management projects are rather benign in terms of business impacts. Access managed corridors generally had lower rates of business turnover than other parts of their communities. They had more rapid growth in retail sales once projects were completed. Far more business owners, when surveyed, indicated that their sales had been stable or increased following project completion than those that reported sales losses. Negative impacts on commerce tend to be confined to a small number of individual businesses. Highlights from the Iowa case studies are as follows:

- There were no particular business categories that consistently decreased in number of establishments for any of the corridors studied. Traffic-dependent businesses such as convenience stores and fast food restaurants did not appear to be affected in a significantly different manner than were all businesses.

- The rates of business turnover in the study corridors ranged from about 2.6 percent to 10 percent per year, a range below or equal to the business turnover rate for Iowa as a whole, which is about 10 percent per year. Businesses located along the case study corridors turned over less than would normally be expected of retail businesses in Iowa.

- With one notable exception, retail sales for businesses within the case study corridors matched or significantly outpaced sales in their respective communities (see chart). No significant short-term declines in retail activity associated with the access management projects were found. Corridor sales generally outpaced community sales throughout the study period.

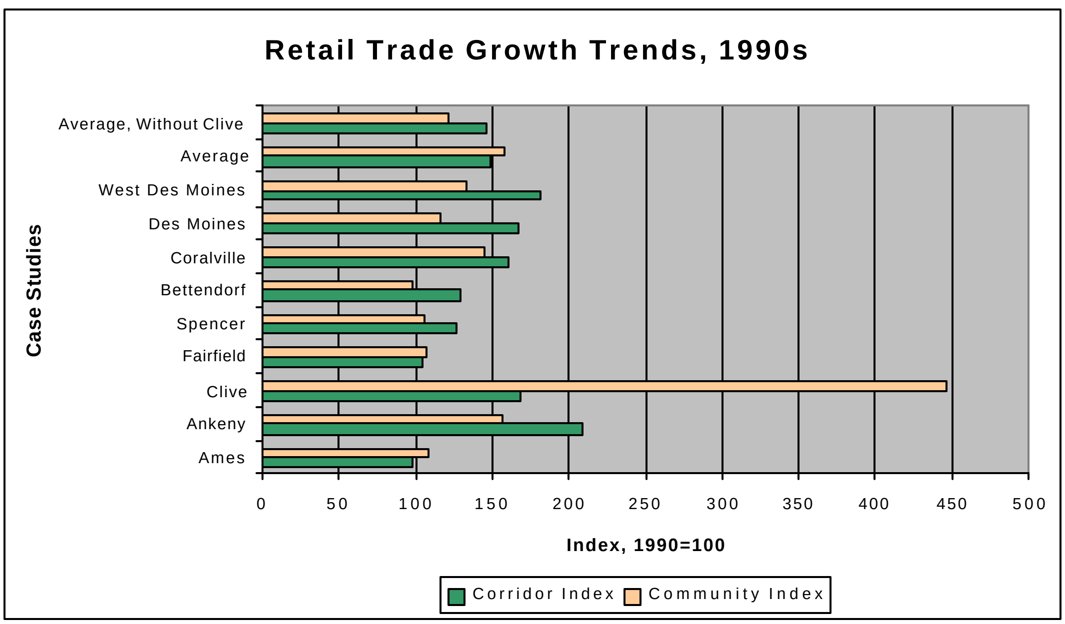
- Over 80 percent of all business owners surveyed along the business corridors that had undergone reconstruction indicated that their sales had increased, stayed the same, or that they were uncertain about the impact. Business owners along raised median projects had both the highest percentage responses of both "increased" and "decreased" sales. Five percent of businesses did report decreased sales activity after the access projects were completed.

- Over 80 percent of business owners reported no customer complaints about access to their businesses. About 19 percent of businesses reported their customers complained or reported some difficulty in driving to their businesses after the completion of the access management project. About half of the businesses reporting complaints were the auto-oriented businesses, including gasoline filling stations, convenience stores, and fast-food restaurants. These businesses report complaints at a higher than proportional rate to their numbers.

- Two-way left-turn lanes generally received high levels of support from business owners and generated low levels of customer complaints. Medians at intersections generated similarly low levels of customer complaints, but appeared to receive lower levels of support from business owners. Auto-oriented businesses adjacent to raised medians at intersections tended to be least supportive of such projects. Continuous raised medians generated the most customer complaints regarding access; however, they also appeared to enjoy high levels of support from business owners.

What have other states experienced?

A 1996 study of twelve highway reconstruction projects in Indiana indicated that the average loss of retail sales <u>during</u> a major project was 13 percent. Those businesses experiencing the biggest temporary losses were gas stations, grocery stores, consumer electronics stores, hardware stores, and automotive sales and service firms. The Indiana study indicates that most businesses achieve a full recovery within two years, although 20 percent of businesses did experience a long-term negative impact on their sales. Mirroring the Iowa results, a majority of businesses reported that they benefited from the project improvements. The majority also supported the projects as necessary. This was because traffic flowed better and access to their location was enhanced. Business types most likely to experience long-term negative effects were gas stations, car washes, and other automotive-related businesses. Results from studies in other states are similar.



Most of the study corridors in Iowa show retail trade growth performance as good or better than their surrounding communities. The one "outlier," Clive, is an unusual situation. Clive is a rapidly developing suburb of Des Moines that has experienced explosive retail growth and draws customers from a large trade area.

Access Management and Pedestrian Safety

Access management is usually promoted as a way to improve driving conditions for motorists. Clearly, access management techniques can lead to roads and streets that are dramatically safer and much easier and more pleasant to drive. However, research also indicates that several key access management techniques are just as valuable to pedestrians. These include

- reducing the number of driveways, particularly commercial driveways, within a given distance (per block or mile)
- providing for greater distance separation between driveway
- providing a safe refuge for pedestrian crossings with raised medians

How does access management help improve pedestrian safety?
Every sidewalk or path that crosses a driveway represents at least four potential pedestrian/vehicle conflict points. Reducing the number of driveways per block reduces the number of conflict points proportionally. Greater separation of driveways promotes pedestrian safety by reducing overlap of the operational areas of driveways. Drivers (and pedestrians) have a difficult time mentally processing more than one conflict point at a time; a greater driveway separation helps them concentrate on one problem at a time.

Safety research also clearly shows that raised medians at street intersections and/or at midblock are a very important design feature for pedestrians. As the table below indicates, roads with raised medians are roughly twice as safe for pedestrians. The intersection crash rate includes crashes that occur at intersections; the midblock figure includes all other crashes.

Roadway Type	Median	Midblock Pedestrian Crash Rate[a]	Intersection Pedestrian Crash Rate[b]
Undivided four lane	None	6.69	2.32
Five lane (TWLTL)	Painted	6.66	2.49
Divided four lane	Raised	3.86	0.97

Source: Oregon State University, 1998.
[a]Per million vehicle miles.
[b]Per million entering vehicles.

On the other hand, two-way-left-turn lanes (TWLTL) effectively reduce automobile crashes on arterial roadways carrying moderate levels of traffic but offer no refuge for crossing pedestrians. The pedestrian safety characteristics of five-lane TWLTL roads are similar to undivided four-lane roads. In order to be effective as a refuge for crossing pedestrians, a median must be at least four feet wide. A wide, depressed (no raised curb) grass median would be a somewhat less effective pedestrian refuge than a raised median.

What are some other corridor design features that help pedestrians?
Other corridor design and access management features that can help pedestrians include the following:

- Right-turn lanes for high-volume driveways. Right-turn lanes provide a dedicated space for vehicles to decelerate and turn using a minimum turn radius. This reduces turning speeds into driveways and allows narrower driveway crossings for pedestrians.

- Sidewalk setbacks. Sidewalks located several feet from the street protect pedestrians by separating them from the traffic flow. If the buffer strip is of an adequate width, drivers can pull completely out of the traffic stream before yielding to a pedestrian. In addition, a landscaped or other clearly marked buffer helps to visually define sidewalk and driveway locations.

- Clear zone. A clear zone free of visual obstructions such as signs, large trees and bushes, or parked vehicles allows pedestrians to be seen by drivers and to see oncoming vehicles.

- Flat cross grade. A flat sidewalk cross grade improves pedestrian safety and is required by the Americans with Disabilities Act (ADA).

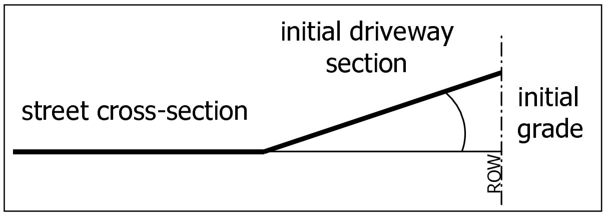
- Signalized midblock crossings. Where feasible, midblock pedestrian crossings can reduce crashes, travel distance, and inconvenience, especially if the distance between signalized intersections is long (0.5 mile).

A pedestrian-unfriendly corridor: high driveway density, poor sight lines, sidewalks next to the street, and no refuge for crossing pedestrians.

Pedestrians using a raised median as a crossing refuge along Lincoln Way near Iowa State University in Ames, Iowa.

Driveway Grade

Along older urban arterial streets, it is common to find rather steep driveways with grades (or slopes) of 5–10 percent or more. Driveways with steep grades were often constructed to allow the driveway and connecting parking lots to drain more efficiently and to save earth-moving costs. On the other hand, more recently constructed arterials typically feature very gentle driveway grades. Driveway grade is an important—yet often overlooked—safety consideration.



The maximum practical grade for driveways varies between 8–14 percent for low-volume driveways and five percent for high-volume driveways (a 30-foot long driveway with a 14 percent grade would rise or fall about four feet along its length). Furthermore, the maximum practical change in grade is about 12 percent. Above this value, many vehicles will scrape their bumpers or other low-hanging parts on the driveway, potentially causing damage to the vehicle and driveway or roadway surface. While this may be the maximum practical grade, it is much safer to use a smaller grade. A minimal grade (say, two percent) is still needed for drainage.

Why is driveway grade important?

Driveway grade is important because it impacts *speed differential*. Turning vehicles must slow appreciably to enter a driveway . The steeper the driveway, the greater the reduction in speed required to prevent “bottoming out.” The following table shows typical driveway entry speeds for varying degrees of driveway grade.

Driveway Grade Change (percent)	Typical Driveway Entry Speed (mph)
Greater than 15	Less than 8
14–15	8
12–13	9
10–11	10
8–9	11
6–7	12
4–5	13
2–3	14
0–2	Approximately 15

Source: Oregon State University, 1998.

High-grade driveway on an older-configuration arterial route in Des Moines, Iowa—grade change forces the motorist to reduce speed to negotiate driveway

Speed differential is the difference between the speed of vehicles that are continuing along the main roadway versus that of those that are turning into or out of the driveway. For instance, if through traffic generally moves at 35 miles per hour and cars have to slow to 10 miles per hour to enter a driveway, the speed differential at that driveway is 25 miles per hour.

A speed differential above 20 miles per hour begins to present safety concerns. When the speed differential becomes greater than 30 to 35 miles per hour, the likelihood of crashes involving fast-moving through vehicles and turning vehicles increases very quickly. Rear-end collisions are very common on roads and streets with large driveway speed differentials and a high density of commercial driveways. When the speed differential is high, it is also more likely that crashes will be more severe, cause greater property damage, and have a greater chance of injury or fatalities. Keeping the speed differential low is very important for safety reasons, as the table below indicates.

Speed Differential between Turning and Through Traffic (mph)	Likelihood of Accidents
10	Low
20	3 times greater than at 10 mph
30	23 times greater than at 10 mph
35	90 times greater than at 10 mph

Source: Oregon State University, 1998.

What is a reasonable driveway grade?

A driveway's vertical profile should allow a smooth transition to and from the roadway. The National Highway Institute's course workbook on access management recommends the following initial driveway grade angles (these grades were all chosen to keep the speed differential at or below 20 miles per hour):

Roadway Classification	Desirable Change in Grade (percent)	Maximum Change in Grade (percent)
Major Arterial	Less than 3	5
Minor Arterial	Less than 4	5
Collector	Less than 5	6
Local	Less than 6	8

When is driveway grade most important?

Steep driveways are not ideal under any circumstances; however, they are more easily tolerated on local streets and roads that carry little or no through traffic. Steep driveways are also more tolerable at residential properties than at retail businesses because residences generate much less traffic. Reducing driveway grade is a very important consideration along roadways that

- carry considerable through traffic volumes
- have relatively high travel speeds (say, 35 to 40 miles per hour or more)
- have commercial land uses along them, especially retail and service businesses that generate high volumes of automobile trips

Access Management Frequently Asked Questions (FAQ):

Driveway Width

Along older urban arterial streets, it is common to find many narrow driveways. Older commercial driveway and parking lot designs tended to use ten to fifteen foot wide driveways. This type of design will safely accommodate only one vehicle at a time, either an entering or an exiting vehicle. Another common problem is driveways in urban and rural areas that are too wide. In some cases, the driveway may have no discernable boundaries or curbs. Both situations create operational and safety concerns. A properly designed driveway helps turning traffic move off the roadway more quickly and reduces the likelihood of crashes.

Why is driveway width important?
Driveway width is important because it impacts speed differential, the difference between the speed of vehicles that are continuing along the main roadway versus those that are turning into driveways. The more a turning vehicle must slow to enter a driveway, the greater the speed differential. As the speed differential increases, the likelihood of crashes involving faster-moving through vehicles and turning vehicles increases quickly. When the speed differential is high, it is also more likely that crashes will be more severe, cause greater property damage, and have a greater chance of injury or fatalities.

This driveway on US 218 in southeastern Iowa is too wide. It lacks curbs and discernable boundaries. This creates confusion for motorists and very unsafe conditions for pedestrians.

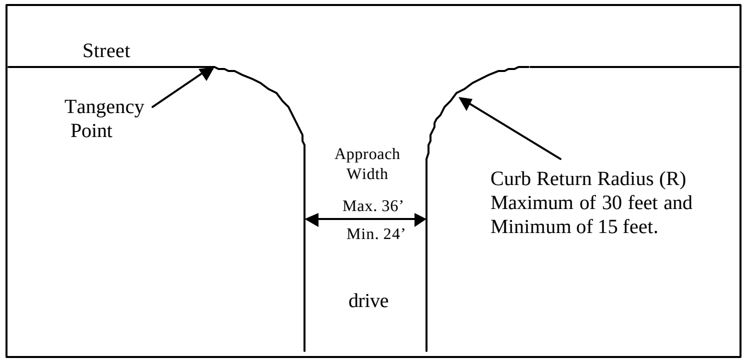
In general, vehicles must slow to a greater extent to negotiate narrower driveways than wider driveways—although the use of longer turn radii and/or tapers will improve operating performance. An additional concern is created when a driveway is so narrow that it can only operate in one direction at a time. In this case, vehicles must wait for others to exit the driveway before entering. This can create a dangerous situation of left-turning or right-turning vehicles stopped in a through traffic lane.

At the other extreme, driveways that are too wide may create confusion for motorists, who may have a hard time deciding where to position themselves, and to pedestrians, who will have a greater distance of pavement to cross where they are vulnerable to being struck by an entering vehicle (see photograph). Such driveways create opportunities for crashes that are fatal or injurious.

What is a reasonable driveway width?
Commercial driveways may vary in size depending on the number of lanes needed. The optimal width for a one-way in or out driveway is 14 to 16 feet. Maximum width driveways usually have two inbound and three outbound lanes, with each lane being at

least 11 feet wide. Where more than one inbound and outbound lane is provided, a median divider is generally desirable. This median should be at least 4 feet wide; however, median widths of 10 to 16 feet are preferable because they improve driver maneuvering and provide opportunities for landscaping. Median widths over 16 feet are undesirable because they create turning problems and greatly expand the intersection size (NCHRP Report 348).

Driveways that enter the public roadway at traffic signals should have at least two outbound lanes—one for right turns and one for left turns (with a minimum width of 22 feet) and one inbound lane of 14 feet minimum width. Dual left-turn lanes into driveways and dual right-turn lanes onto public streets should be used only with traffic control.



The above diagram shows a driveway width standard from the City of College Station, Texas for 2-way commercial and multifamily driveways. In this case, the maximum width shall not exceed 36 feet and the minimum width shall not be less than 24 feet. Turn radii may vary between 15 and 30 feet.

All *noncommercial* (residential) driveways should normally have a width between 14 feet and 24 feet. Where larger vehicles (farm equipment or trucks) will use a driveway, at least a 20-foot width should be provided.

Many different combinations of turn radius and driveway width provide the same level of driveway operations. For a given level of service, shorter radii require wider driveways than longer radii. For example, a 33-foot wide two-lane driveway with 5-foot turn radii provides about the same level of service as a 37-foot wide drive with a square corner. NCHRP Report 348 recommends that agencies select a very limited number of standard designs for driveways so designs are consistent.

When is driveway width most important?

Narrow driveways are not ideal under any circumstances, however they can best be tolerated on local streets and roads that carry little of no through traffic. Narrow driveways are more tolerable for residential properties than for retail businesses, since businesses generate many more vehicles entering and exiting driveways per hour. Increasing driveway width thus becomes a very important consideration along roadways that:

- Carry considerable through traffic volumes;
- Have relatively high travel speeds—say 35 to 40 miles per hour or more;
- Have commercial land uses along them, especially retail and service businesses that generate many hourly auto trips.

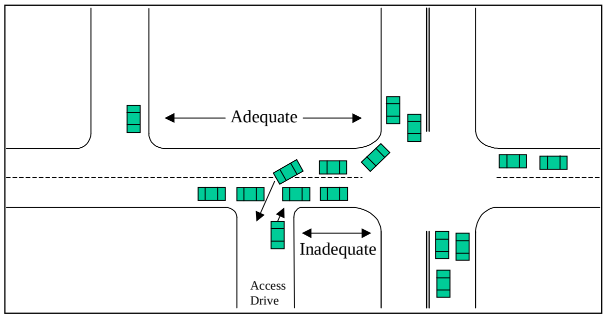
What are some related issues?

Driveway turn radius, driveway grade, internal circulation in land developments (includes driveway throat length), driveway-related crashes, and speed differential between turning vehicles and through traffic.

Clearing Driveways Away from Corners

Clearing driveways away from corners is the simplest, yet perhaps the most critical access management treatment.

What is corner clearance?
Corner clearance is the minimum distance required between an intersection and an adjacent driveway along an arterial road or collector street (see figure below).



Why is corner clearance important?
According to National Cooperative Highway Research Report 420, inadequate corner clearance results in traffic flow and safety problems, including

- traffic blocked by vehicles waiting to enter driveways
- right or left turns out of driveways being blocked
- rear-end and broadside collisions caused by inadequate time for motorists to react to vehicles entering and exiting the driveway
- driver confusion about where it is permissible to enter and exit the driveway

What's a reasonable distance between an intersection and the first driveway opening?
Corner clearance standards vary greatly from state to state and city to city. For instance, the standard in Colorado is 325 feet on arterials with 40 mile per hour speed limits; it is 50 feet in Virginia, which is about three car lengths. Most state and local standards range from 75 feet (about five car lengths) to 250 feet (about 16 car lengths). The 250-feet figure corresponds to the minimum distance required to stop a car traveling 35 miles per hour. Ideally, corner clearances on major roadways should be the same as driveway spacing requirements. When this cannot be achieved because of a lack of frontage, the upstream corner clearance should be longer than the longest expected queue at the adjacent intersection.

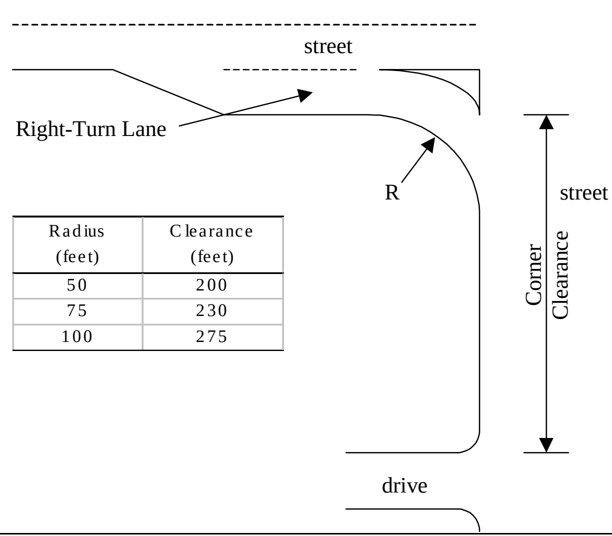
What other factors are important to corner clearance?
If a corner has a large radius or if there is a dedicated right-turn lane at the corner, the first driveway downstream from the corner should be located farther away from the corner. This extra distance allows drivers to negotiate turns at a higher rate of speed and a greater distance to slow or stop. The Florida Department of Transportation and some cities and counties in Florida have set downstream corner clearance standards higher as a result.

What about in rural areas?
Corner clearance is even more important to maintain in rural areas because travel speeds are higher. The minimum distance it takes to stop a car traveling at 55 miles per hour is 550 feet, while at 35 miles per hour the distance is only 250 feet.

A long corner clearance at a new convenience store on University Avenue in Windsor Heights, Iowa. The first driveway is over 75 feet (five car lengths) from the corner on the left side of the picture.

An insufficient corner clearance can create an operational and safety hazard. This intersection is ranked within the top 100 crash sites in Iowa.

DOWNSTREAM CORNER CLEARANCE



Radius (feet)	Clearance (feet)
50	200
75	230
100	275

A downstream corner clearance standard from College Station, Texas. It specifies a very long corner clearance where there is a dedicated right-turn lane.

Access Management Frequently Asked Questions (FAQ):

Shared/Joint Driveways and/or Cross Access

Driveway spacing and driveway density are important considerations in managing access. When driveways are spaced too closely together or the number of driveways per block or mile becomes too large, a significant increase in traffic accident rates occurs. Traffic also tends to become congested more quickly in such situations.

What is driveway sharing?
A shared driveway is when two or more adjacent properties use the same driveway for ingress and/or egress. Shared driveways are very common in newer commercial areas, for instance at strip malls, regional shopping centers, and office parks. Sharing driveways is simply good design practice since conflict points caused by motorists entering and leaving the businesses are reduced. This will, in turn, tend to reduce traffic accidents associated with turning traffic and improve the traffic flow on the main road.

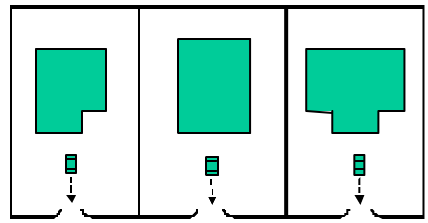
What are joint and cross access?
Joint and cross access are formal, legal methods of ensuring that adjacent properties can share driveways. In the case of joint access, two adjacent property owners share a driveway along their common property line. In the case of cross access, one property owner has the legal right to access and use a driveway that is on the adjacent property owner's land.

Joint and cross access can be built into private real estate titles through easements. They can also be encouraged or required in local planning or design standards or in municipal and county ordinances.

When are driveway sharing and joint and cross access most valuable?
Sharing driveways is most valuable as an access management strategy when property frontages are short, in other words when the number of commercial properties along a typical, 400 to 500 foot block face is more than three or four.

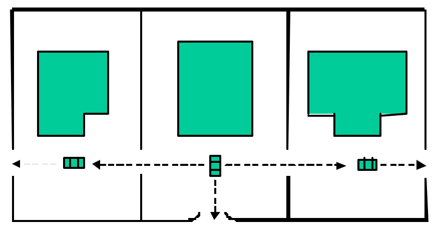
A rule of thumb on driveway sharing in an urban or suburban area might be that properties with less than 50 to 60 feet of frontage along an arterial street should not have individual driveways. These properties would share drives with neighboring properties. Three to four commercial driveways per block face is a desirable maximum standard for an urban or suburban arterial street. This means that when there are more than three or four parcels or commercial buildings on a block face, driveway sharing and cross access should be strongly encouraged. When the number of parcels and potential driveways along a block face is small, driveway sharing and joint and cross access are not needed.

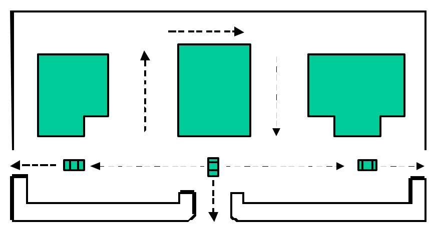
Avoid



Promote

- Cross Access - Internal connections between adjacent sites
- Joint Access - Driveways serving multiple sites
- Complete on-site circulation

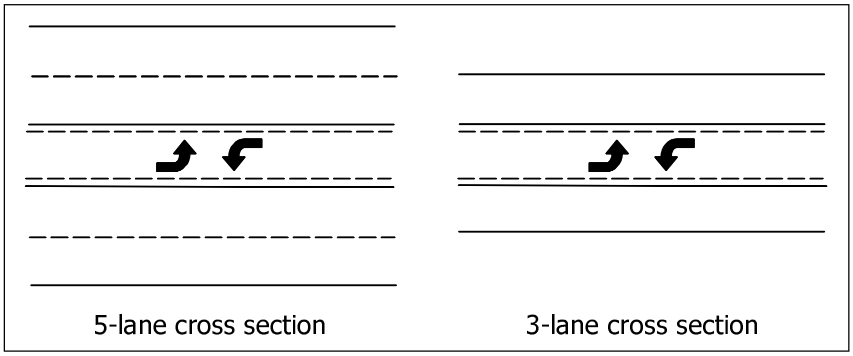




Several businesses share a common driveway in West Des Moines, Iowa.

Continuous Two-Way Left-Turn Lanes

Continuous two-way-left-turn lanes (TWLTL) are a common access management treatment when combined with driveway consolidation and corner clearance. TWLTLs simultaneously provide a separate lane for left turning vehicles and property access. Typically, they are used as the center lane of a five-lane roadway. A less common design involves three lanes, a TWLTL in the center for left turns and one lane in each direction for through traffic. Figures below demonstrate.



Why is there a need for TWLTLs?
From the 1950s though the 1970s, many arterial and collector roads and streets were constructed with either two lanes or four lanes and no turn lanes or medians. Since all lanes served both through traffic and turning traffic, these roads began to operate less efficiently and safely as the volume of turning traffic grew. In many cases, this may have been caused by unmanaged development and access along the roadway. When such roads experience a considerable amount of left-turning traffic, congestion delays and crashes increase. Types of crashes most associated with turning vehicles include rear-end and broadside collisions.

Because TWLTLs separate left-turning traffic from through traffic, they can help solve some of these problems. A detailed accident study conducted in Minnesota between 1991 and 1993 of arterials in urban areas indicates that three-lane roadways are about 27 percent safer than four-lane undivided roadways and five-lane roadways are about 41 percent safer than four-lane undivided roadways (see table below).

Roadway Type (All Urban Arterials)	**Crash Rate (Crashes per Million Vehicle Miles)**
4-lane undivided	6.75
3-lane with center turn lane	4.96
4-lane with median	4.02
5-lane with center turn lane	4.01

Source: BRW, Inc., study for the Minnesota Department of Transportation, August 1998.

When should continuous TWLTLs be considered?
In general, TWLTL projects function well when traffic levels are moderate, the percentage of turning volumes is high, and the density of commercial driveways is low to

moderate. TWLTLs will function very well on most arterials where traffic volumes average from 10,000 to 28,000 vehicles per day.

TWLTLs can also work very well in places where the number of driveways per block or mile is high but the land use does not produce many turning movements per hour. An example would be an arterial through a predominantly residential area.

South Duff Avenue in Ames, Iowa, after retrofit in 1994 with a continuous TWLTL (five lanes) and a driveway management and consolidation program. After completion of the project, the crash rate fell by about 70 percent and traffic operations improved one full level of service even though traffic volumes increased seven percent.

State Street (US 67) in Bettendorf, Iowa, after retrofit in 1996 with a continuous TWLTL (five lanes). After completion of the project, the crash rate fell by more than one-half and traffic operations improved one full level of service even though traffic volumes increased eight percent.

When should continuous TWLTLs be avoided?
TWLTLs begin to lose their effectiveness when traffic volumes on a roadway are high. A Georgia Tech University study indicates operating degradation occurs between an average annual daily traffic (AADT) of 24,000 to 28,000 vehicles per day. This would be a relatively high level of traffic level in Iowa. TWLTLs are also much less effective in situations where commercial driveway densities are high and these driveways are closely spaced. In such a situation, the number of conflict points is high and this will be reflected in crash rates. If TWLTLs are considered, driveway density and driveway spacing *must* be managed aggressively.

TWLTLs are not recommended in situations where there are more than four through traffic lanes (e.g., two through lanes in each direction). Several states in the southeastern United States have constructed seven lane urban arterials where one lane is a TWLTL. These roadways have accident rates as high as 11 accidents per hundred million vehicle miles. This is similar to an undivided roadway with a high number of access points per mile. Many of the accidents on these roads occur because drivers may have to cross as many six or seven lanes (with traffic moving in several directions) to enter or exit a business. This represents too complex a situation for drivers to manage. When there are six or more through traffic lanes, a raised median is essential.

Three-Lane Roadways with Two-Way Left-Turn Lanes

Continuous two-way left-turn lanes (TWLTL) are a common access management treatment. Typically, they are used in the center of a four-lane roadway. However, a less-common design involving three lanes—a TWLTL in the center for left turns and one lane in each direction for through traffic—is being used more and more frequently. At first, the idea of a three-lane road may seem strange. But under the right circumstances they can work very well, operating better and more safely than a four-lane undivided road.

Why is there a need for three-way street designs?
From the 1950s though the 1970s, many arterial and collector roads and streets were constructed with either two lanes or four lanes and no turn lanes or medians. Since all lanes served both through traffic and turning traffic, these roads began to operate less efficiently and safely as the volume of turning traffic grew. In many cases, this may have been caused by unmanaged development and access along the roadway. When such roads experience a considerable amount of turning traffic, congestion delays and crashes increase. Types of crashes most associated with turning vehicles include rear-end and broadside collisions.

Because TWLTLs separate left-turning traffic from through traffic, they can help solve some of these problems. A detailed accident study conducted in Minnesota between 1991 and 1993 indicates that three-lane arterial roadways in urban areas are about one-quarter (27 percent) safer than four-lane undivided urban arterial roadways (see table below). In fact, three-lane roads approach the safety level of much wider four-lane roadways with medians or five-lane roadways and can cost far less to build. They also fit in a smaller right-of-way, which can mean less disruption to adjacent properties.

Roadway Type (All Urban Arterials)	Crash Rate (Crashes per Million Vehicle Miles)
Four-lane undivided	6.75
Three-lane with center turn lane	4.96
Four-lane with median	4.02
Five-lane with center turn lane	4.01

Source: BRW, Inc., study for the Minnesota Department of Transportation, August 1998.

Where can three-lane street designs be used?
Three-lane roadway designs can be effectively used in situations with low to moderate levels of through traffic that have safety concerns about left-turning traffic. The upper average daily traffic (ADT) limit for using a three-lane design is about 17,000 vehicles per day of traffic. Three-lane designs are ideal where right-of-way width is limited by land development or other constraints. Three-lane roads can be originally designed this way or created by widening an existing two-lane route or modifying an existing four-lane undivided route.

Where should three-lane street designs be avoided?

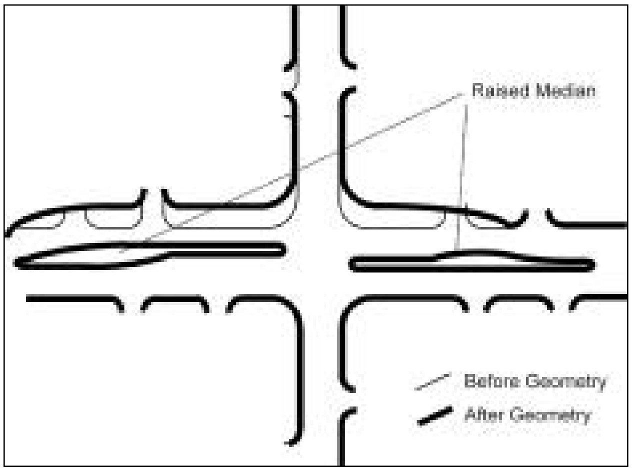
Three-lane roadway designs with TWLTLs should generally not be used in situations where the through traffic volume is substantial. When the ADT on a street exceeds about 17,000 vehicles per day, a three-lane road may start to become ineffective. In such cases, four-lane roadways with raised medians or five-lane roadways with TWLTLs may be more appropriate designs.

A three-lane street with a two-way left-turn lane in West Des Moines, Iowa.

A four-lane undivided street operating as a “defacto” three-lane street. Most of the through traffic is in the outside lane, and the inside lane is used almost exclusively by turning traffic. These streets are candidates for conversion to three-lane streets.

Raised Medians at Intersections

Raised medians with left-turn lanes at intersections offer a cost-effective means for reducing accidents and improving operations at higher volume intersections. The left-turn lanes separate slower turning vehicles from through traffic and provide a protected space for these vehicles to decelerate and turn. The raised median prohibits left turns into and out of driveways that may be located too close to the functional area of the intersection.



The above retrofit project shows the installation of a raised median with left-turn lanes at an intersection. The project was conducted in conjunction with a program for managing access to driveways located within the functional area of the intersection. In this example, some driveways were closed, consolidated, and cleared away from the intersection.

When are raised medians at intersections most effective?
Raised medians at intersections may be most effective in retrofit situations where high volumes of turning vehicles have degraded operations and safety, and where more extensive approaches would be too expensive because of limited right-of-way and the constraints of the built environment.

Because raised medians limit property access to right turns only, they should be used in conjunction with efforts to provide alternative access ways and promote driveway spacing objectives (driveways should not be located too close to the intersection or other driveways). To minimize the potential for any negative business impacts, affected businesses and property owners should be involved in the project throughout the planning, design and construction phases.

What is an example of an intersection that has benefited from raised medians?
A raised median located at the intersection of US Highway 18 (4th Street SW) and Pierce Avenue in Mason City, Iowa, decreased crashes by almost 40 percent during a three-year period following its completion in 1991. The project also involved changes in the number and configuration of commercial driveways. The intersection had become one of the state's top 100 improvement candidate locations. Turning traffic, both at the intersection and at commercial driveways located within the functional area of the intersection, was the major reason for the high crash rates. The left-turn lanes protected left-turning

vehicles from rear-end collisions by allowing them to diverge from through traffic at a relatively low *speed differential*. The raised median separated opposing traffic and reduced traffic *conflict points* by eliminating left turns into and out of driveways located near the intersection. The improvement in safety and traffic flow took place even though traffic volumes increased almost 16 percent after the project was completed.

What are other design considerations of raised medians at intersections?

- The length of the turn/deceleration lane. Turn lanes must be long enough to allow safe deceleration and provide storage for turning vehicles—that is, prevent queuing vehicles from backing up into the travel lanes.

- The minimum width of the median at the "nose." Very narrow median noses are difficult to see, especially at night and in inclement weather. A width of six to eight feet is preferable and provides a safe refuge for pedestrians.

- Visibility of the median. Carefully selected landscaping may be the most effective way to provide excellent visibility of the median, especially where the median islands begin. Reflective paint tends to wear and lose its reflectivity because of weather.

- The length of taper. The length of taper, or the portion of the median opening that begins the transition to the turn lane, is generally based on the approach speed: the faster the speed, the longer the taper.

- Related issues. Related issues include continuous raised media, comparison of raised medians and two-way left-turn lanes, functional areas of intersections, dedicated left and right turning lanes, speed differential between turning vehicles and through traffic, and corner clearance.

Raised median at intersection of University Avenue and 63d Street in Des Moines, Iowa. Land use at corner is primarily commercial.

Raised median, landscaped with brick paving, at intersection of Douglas Avenue and 72d Street in Urbandale, Iowa. Adjacent land use is residential.

Continuous Raised Medians

Continuous raised medians with well-designed median openings are among the most important features for managing access to create a safe and efficient highway system.

What are the advantages of continuous raised medians?
Physical medians prevent accidents caused by crossover traffic, reduce headlight glare distraction, and separate left-turning traffic from through lanes when combined with left-turn lanes. A detailed accident study conducted in Minnesota between 1991 and 1993 indicates that four-lane urban arterial roadways with medians are 40 percent safer than four-lane undivided urban arterial roadways (BRW, Inc., for the Minnesota Department of Transportation, 1998).

Continuous landscaped raised median on 100th Street in Clive, Iowa. Left-turn lanes are provided at intersections at widely spaced intervals.

Iowa Highway 28 (1st Street/63d Street) in West Des Moines/Des Moines after retrofit with a continuous raised median, left-turn lanes at major intersections, driveway consolidation, and some widening of business driveways. Some property was purchased to accommodate a wider right-of-way.

A continuous raised median retrofit project along Iowa Highway 28 in West Des Moines/Des Moines (1st/63d street locally; see above right) reduced crashes by about 51 percent. Prior to project completion, the crash rate was about 6.7 per million vehicle miles traveled (VMT). After project completion, the crash rate declined to 3.3 crashes per million VMTs, a figure indicative of a very safe roadway. This experience is consistent with other projects studied in Iowa.

By removing left-turning vehicles from through traffic, continuous raised medians with left-turn lanes at intersections and major driveways help maintain roadway operating speed. This, in turn, reduces fuel consumption and tailpipe emissions. The Iowa Highway 28 project improved the flow of traffic and reduced congestion problems associated with stopped left-turning traffic. The corridor can now successfully accommodate higher traffic levels without an increase in safety problems.

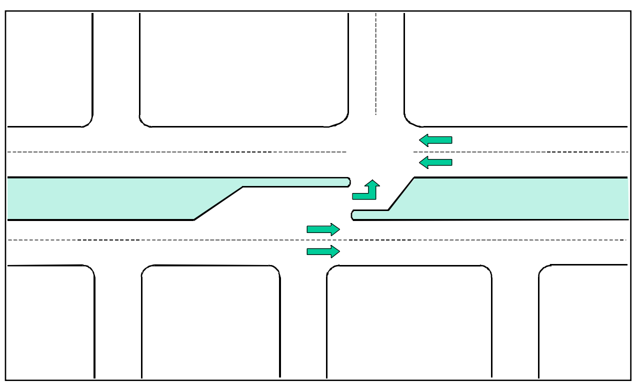
Other advantages of continuous raised medians are that they (1) discourage strip development, (2) allow better control of land uses by local government, (3) provide better pedestrian protection than undivided roadways, painted islands or two-way left turn lanes, and (4) provide space for landscaping and other aesthetic treatments.

When are continuous raised medians most effective?
Continuous raised medians are most effective on roadways with high traffic volumes and high driveway densities. To ensure the greatest positive impact on safety and operations, this approach should be combined with a driveway consolidation program.

What are the disadvantages of continuous raised medians?
Continuous raised medians tend to limit property access and may force motorists to make circuitous routes to reach minor destinations, thereby increasing their travel time. Continuous raised medians may concentrate left turns and increase the frequency of U-turns. Roadways with continuous raised medians also require a wider right-of-way than do undivided roadways.

Because of such limitations, businesses and land owners will oppose a raised median project if they believe it will limit access to their property, especially if they perceive it will block customers trying to make left turns into their property. Therefore, it is important to involve all major stakeholders in key design and construction decisions—especially when retrofitting existing roadways. If properly done, the public outreach program should result in a project that is acceptable to all major stakeholders. Raised medians do not necessarily hurt business vitality. See FAQ #8, “Benefits of Access Management.”

What are other design considerations of continuous raised medians?
When medians extend the full length of a road, the spacing of intersections and median breaks are crucial to providing access to properties on both sides of the road. Median breaks should generally only be provided at public road intersections or at driveways shared by several businesses. They should generally not be provided for access to individual businesses or residences. The number of median breaks should be kept to a minimum since they add conflict points and detract from safety.



The directional median break allows for left turns onto the side street. The median prevents vehicles from crossing the arterial and making left turns from side streets onto the arterial.

On major arterials, the Florida Department of Transportation recommends one-half mile spacings between full median openings and one-quarter mile spacings between directional median openings. On minor arterials, it recommends one-quarter mile spacings between full median openings (for posted speed limits under 45 miles per hour) and one-eight mile spacings between directional openings. Median openings should never be built into the functional areas of other median openings or intersections.

Where is there more information on related issues?
See FAQ # 19 (“Comparison of Raised Medians and Two-Way Left-Turn Lanes”), FAQ # 17 (“Raised Medians at Intersections”), FAQ #21 (“Dedicated Left and Right Turning Lanes”), and FAQ #6 (“Conflict Points”).

Comparison of Raised Medians and Two-Way Left-Turn Lanes

Because raised medians are the most restrictive access management treatment, building a raised median along an arterial is often very controversial among business and property owners. Two-way left-turn lanes (TWLTL) are much less so. Business persons and property owners feel that installation of raised medians will have a large, negative impact on their customers, sales, and property values. Therefore, TWLTLs are often suggested as a compromise solution. However, TWLTLs also represent a safety compromise when compared to raised medians. They should be used with care.

When should raised medians be used and why?
When the average annual daily traffic (AADT) volume on an arterial roadway is projected to exceed about 28,000 vehicles per day during the next 20 years, including a raised median is prudent.

Arterial roadways with raised medians are safer and operate better than any other access management cross-section configuration. Research indicates that raised median roadways are 25 to 30 percent safer than undivided roadways in urban areas.

When should two-way-left-turn lanes be considered?
In general, TWLTL projects function well when traffic levels are moderate, the percentage of turning volumes are high, and the density of commercial driveways is low. TWLTLs will function well on most arterials with low to moderate commercial driveway density and where the AADT is in the range of 10,000 to 28,000 vehicles per day.

TWLTLs can also work very well in places where the number of driveways per block or mile is high but where the land use does not produce many turning movements per hour—for example, an arterial through a predominantly residential area.

When should two-way-left-turn lanes be avoided?
TWLTLs begin to lose their effectiveness when traffic volumes on a roadway are high. A Georgia Tech University study indicates operating degradation occurs between an AADT of 24,000 to 28,000 vehicles per day. This is a relatively high level of traffic level for many Iowa cities.

TWLTLs are also much less effective in situations where commercial driveway densities are high and these driveways are closely spaced. In such a situation, the number of conflict points is high and this will be reflected in crash rates. Research from many states indicates that raised median roadways are *always* safer than TWLTL roadways (see table). If TWLTLs are considered, driveway density and driveway spacing *must* be managed aggressively.

Access Points per Mile	Undivided Roadway (Painted Centerline)	TWLTL	Raised Median	Accident Rate Reduction for Raised Median vs. TWLTL
Fewer than 20	3.8	3.4	2.9	-0.5
20 to 40	7.3	5.9	5.1	-0.8
40 to 60	9.4	7.4	6.5	-0.9
Over 60	10.6	9.2	8.2	-1.0

Source: National Cooperative Highway Research Program Report 3-52.
Note: Representative accident rates per hundred million vehicle miles traveled.

Where are raised medians preferable to TWLTLs?
The use of a median is also a more prudent road design in situations where it is difficult to predict future traffic volumes. For example, a rapidly growing suburb with a large potential for new retail development should probably design or retrofit its arterial streets with raised medians in anticipation of high future traffic volumes.

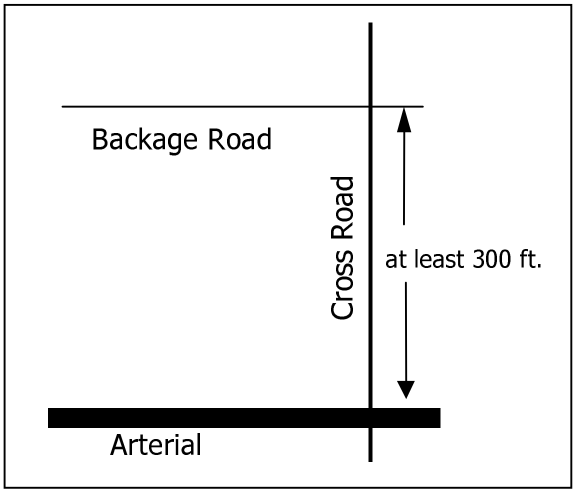
TWLTLs are also not recommended in situations where there are more than four through traffic lanes (e.g., two through lanes in each direction). Several states in the southeastern United States have constructed seven-lane urban arterials where one lane is a TWLTL. These roadways have accident rates as high as 11 accidents per hundred million vehicle miles. These are similar to the rates of an undivided roadway with a high number of access points per mile. Many of the accidents on these roads occur because drivers may have to cross as many six or seven lanes (with traffic moving in several directions) to enter or exit a business. This represents too complex a situation for many drivers to manage. When there are six or more through traffic lanes, a raised median is essential.

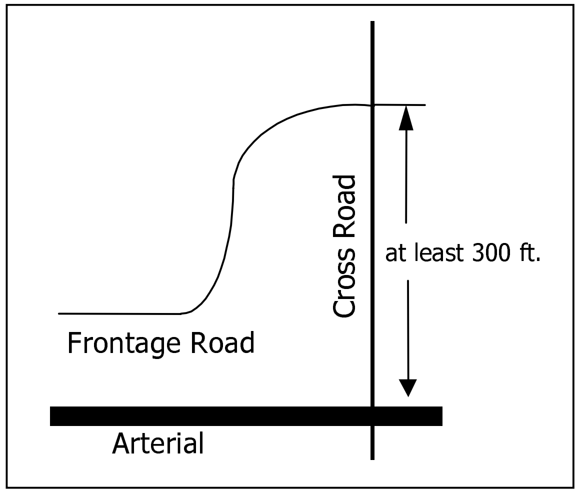
Five-lane arterial with a TWLTL, 50th Street in West Des Moines, Iowa.

Four-lane arterial with raised median, Ankeny Boulevard, Ankeny, Iowa.

Frontage and Backage Roads

Frontage and backage roads run parallel the mainline route and provide alternative access to property (see figures below). Property access is provided along the frontage or backage road, which accesses the arterial via a cross road (with a traffic signal if necessary). This reduces the number and density of conflict points associated with strip development. These roads are generally applicable to commercial development.





A *backage road* provides access to the rear side of commercial properties located between the backage road and the arterial. It also provides access to properties located on the opposite side of the backage road from the arterial, thus increasing land values and reducing infrastructure costs to individual properties.

A *frontage road* provides access to the front side of commercial properties located along the arterial. Care must be taken to ensure adequate separation between the arterial and the intersection of the frontage and cross roads.

Why are frontage and backage roads important?

Frontage and backage roads reduce conflict points between through traffic and turning traffic associated with strip development and direct property access to the arterial. Conflict points are associated with reduced levels of roadway safety and operations. Studies have shown that when driveway access to arterial roadways is granted to too many property owners without considering future traffic volumes and roadway classifications, the additional driveways increase the rate of accidents and decrease the efficiency of the roadway. NCHRP Report 3-52 shows that accident rates increase dramatically as the number of driveways per mile increases along urban arterial roadways.

When are frontage and backage roads most effective?

Frontage and backage roads are most effective on relatively heavily traveled, higher speed arterials. Opportunities to construct access roads are generally restricted to locations where there is substantial spacing between intersecting roads, little if any existing development, and a development plan. Retrofit may be possible where setbacks for developed properties or the availability of land behind developed properties is sufficiently large.

What are some design considerations of frontage and backage roads?
Frontage roads near arterials may cause more problems than they solve if they are not set far enough back from an arterial. If frontage road outlets are set back only one or a few car lengths from the arterial, cars exiting the frontage road enter the functional area of the arterial intersection, creating conflict points with other vehicles. This situation can worsen as further development occurs along the frontage road. The Transportation Research Board recommends a separation of at least 300 feet between frontage road outlets and intersections between cross streets and arterials. This should be considered a bare minimum and should be higher if possible (see FAQ #4, "Intersection Spacing and Traffic Signal Spacing"). In rural areas, higher operating speeds dictate longer separations.

Backage roads with development along both sides are preferable to frontage roads because they allow for greater distance between the connection to the cross street and the intersection with the arterial.

How else do backage roads compare with frontage roads?
In comparison to frontage roads, backage roads provide access to a greater number of individual properties (assuming development along both sides of the road). This increases the value of the land and reduces road construction costs for individual properties. Backage roads are increasingly becoming more common.

Frontage roads along Douglas Avenue in Urbandale, Iowa. The frontage road system is visible on both sides of the main roadway.

Dedicated Left and Right Turning Lanes

One of the major concerns of transportation engineers and planners in cities and suburban areas is keeping through traffic moving at a smooth and even pace. When traffic can't move at an even pace, delays and congestion are the result. This frustrates motorists and creates opportunities for "fender-bender" crashes. One of the simplest ways to accomplish smooth and even traffic is to remove the turning traffic from the through traffic flow at road intersections and near busy driveways. Often, dedicated turning lanes are provided to serve that purpose. Many times turning lanes are used in conjunction with raised medians and medians at intersections to provide additional safety by protecting turning traffic.

Why are turning lanes used?
In the past, many arterial and collector roads and streets in Iowa were constructed with either two or four undivided lanes. All of the lanes served both through traffic and turning traffic. When there is a considerable amount of turning traffic, undivided multilane roads become more and more difficult to drive on because of what traffic engineers call "side friction." Turning traffic reduces the capacity of lanes to carry through traffic. Congestion and delay both rise. Types of crashes associated with turning vehicles become more common; these include rear-end collisions and broadside crashes.

Dedicated turning lanes allow through traffic to keep moving, thus avoiding some potential for rear-end collisions. The combination of medians and turning lanes provides protection for turning traffic, thus reducing the number of broadside collisions.

Where can turning lanes best be used?
Designated turn lane designs can be effectively used in situations where there are moderate to high levels of through traffic yet concerns exist about conflict points and crashes caused by turning traffic. 4th Avenue SW in Mason City carries about 10,000 vehicles per day very efficiently. Left and right turn lanes are ideal where right-of-way width is not greatly limited because of existing land development or other constraints.

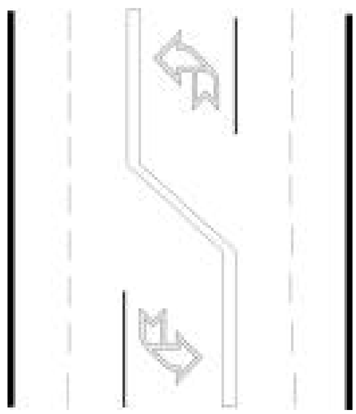
Designated turning lanes can either be designed that way originally or can be created by widening an existing two or four-lane route. Raised medians can be added along the entire roadway or at and near intersections with other roads to provide additional safety.

What are the main benefits of turn lanes?
- Improved traffic safety
- Increased travel speed, reduced delay, and reduced congestion

A good example of the impact of adding dedicated turning lanes and limited raised medians is on 4th Avenue SW near Pierce Avenue in Mason City, Iowa. The crash rate on 4th Avenue SW was reduced by some *40 percent* simply by adding the left-turn lanes and medians to protect the traffic using them. The improved road was also able to carry

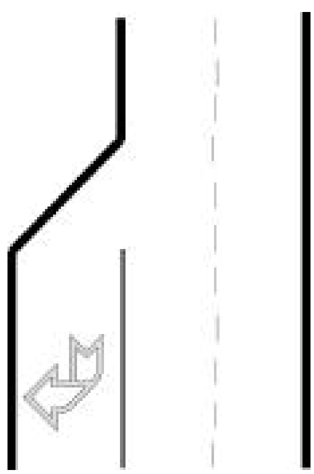
16 percent additional traffic while providing the same level of service to motorists in terms of travel time, delay, and congestion. This project is very popular with the motorists who use it daily.

Left Turn Lanes



Left-turn lanes and raised medians on Lincoln Way in Ames, Iowa.

Right Turn Lane



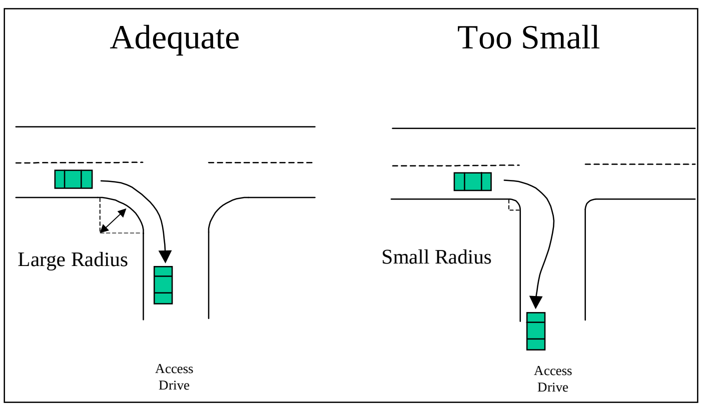
Right-turn lane at a major commercial driveway on US 69 (Duff Avenue) in Ames, Iowa.

Are there related issues that should also be considered?
The following issues may impact dedicated turn lane decisions: speed differential between turning vehicles and through traffic, conflict points, raised medians at intersections, continuous raised median, continuous two-way left turn lanes, functional areas of intersections, and corner clearance.

Driveway Turn Radius

Turn radius refers to the extent that the edge of a commercial driveway is "rounded" to permit easier entry and exit by turning vehicles. Driveway entrances with longer turn radii help slower, turning traffic move off the arterial more quickly. They also help traffic leaving a driveway turn and enter the stream of traffic more efficiently. Guidelines for turn radii are generally applied to nonresidential developments and subdivisions.

Why is turning radius important?
Driveway turn radius is important because it impacts *speed differential*, the difference between the speed of vehicles that are continuing along the main roadway versus those that are turning into or out of the driveway. Keeping the speed differential low is very important for safety reasons. Turning vehicles must slow appreciably to enter a driveway. Longer turn radii allow vehicles to turn into and out of driveways at a higher speed (see figure below). They also prevent turning vehicles from encroaching upon oncoming traffic or traffic in adjacent lanes.



A longer turn radius creates a more rounded corner. This allows the vehicle to enter and exit the driveway more quickly and without encroaching upon traffic in adjacent lanes.

When is turn radius most important?
Longer radii are most desirable in situations where vehicles are exiting from a higher speed roadway or when a high volume of driveway traffic is expected. In practice, sufficiently long turn radii can be achieved by designing the driveway to accommodate the largest vehicle expected to use the driveway. For example, designing a driveway to accommodate the unrestricted entry of the occasional delivery truck or bus ensures a higher entry speed for automobiles.

What is a reasonable turn radius?

NCHRP Report 348 recommends a minimum 25-foot turn radius in urban areas, although a 35-foot radius may be needed to accommodate buses and single unit trucks. In most suburban settings, 25 to 50 foot radii are desirable; however, longer radii are desirable where turning islands or dual turning lanes are provided. A minimum 15-foot radius is recommended in areas of heavy pedestrian traffic such as business districts and school crossings. Shorter radii are recommended only for residential drives from low-speed roadways.

What factors should influence the turn radius?

The preferred turn radii will depend, primarily, on the type of vehicles to be accommodated, the number of pedestrians crossing the driveway, and the operating speeds of the accessed roadway. Because larger vehicles require longer turn radii, the turn radii should be designed to accommodate the largest vehicle generally expected to use the driveway. For example, a driveway to a service station should be designed to accommodate a gasoline delivery truck. Tight radii should only be used for serving residential drives from low-speed roadways.

In addition, turning radii and driveway throat width are interrelated: Many different combinations of turn radius and driveway width provide the same level of driveway operations. For a given level of service, shorter radii require wider driveways than longer radii. For example, a 33 foot wide two-lane driveway with 5-foot turn radii provides about the same level of service as a 37 foot wide drive with a square corner. NCHRP Report 348 recommends that agencies select a very limited number of standard designs.

How does the turn radius impact pedestrian safety?

The use of longer turning radii should also consider the impact on pedestrian safety. A tradeoff may be involved where pedestrian safety is a key concern. Longer turning radii increase the distance of the pedestrian crossing and allow for higher vehicle speeds. Solutions include shortening the turning radii or introducing a pedestrian refuge island in the driveway.

Are there issues that should be considered in conjunction with turn radius?

Driveway turn radius is closely related to the following access management subjects: driveway width, driveway grade, internal circulation in land developments (including driveway throat length), driveway-related crashes, and speed differential between turning vehicles and through traffic.

Internal Circulation in Land Developments

Internal site design is probably the most neglected discussion point in access management. It would be natural to think that access management concerns stop at the roadway right-of-way line, but in fact they carry through into the property that is provided with access.

Why is internal site design important?
The movement of traffic into and out of properties can be dramatically affected by the internal design for on-site circulation. The internal design of circulation on a property may help or hinder traffic turning off or onto an arterial street. This in turn affects the speed differential between turning and through traffic.

What is the best way to design for internal circulation?
The internal circulation of a land development functions well when it is designed with respect to highway access point(s) rather than the building(s). Design should start from the outside in and finish with the parking and building. Very often, the opposite approach is taken. The circulation design of driveways and parking lots are done last. Here is the optimal internal circulation design approach:

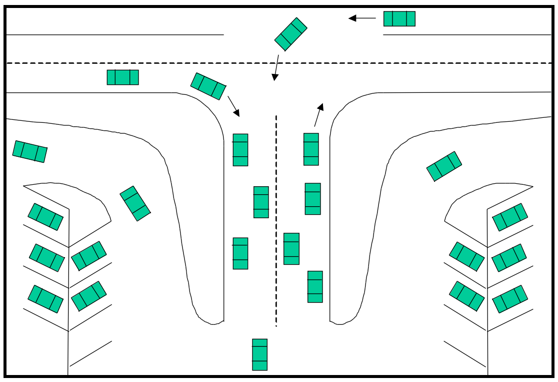
1. Provide safe and reasonable access to and from the street to motorists and pedestrians.
2. Provide a reasonable transition between the access and the internal circulation, especially by making sure the driveways are wide and long enough.
3. Design the parking area and individual parking spaces.
4. Design the building footprint within the constraints of the internal circulation and the parking.

What is the "throat length" of a driveway and why is it important?
The throat length is the distance between the street and the end of the driveway inside the land development. The following table provides recommended throat lengths:

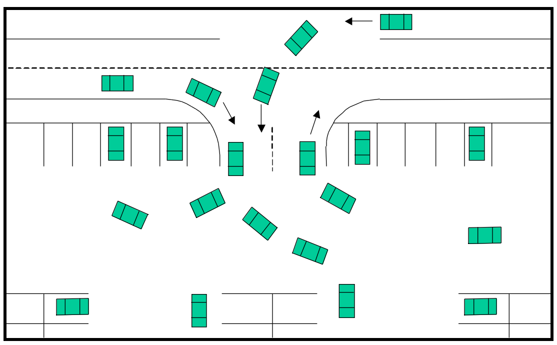
Commercial Development Type	Recommended Driveway Throat Length
Large and medium shopping centers with greater than 200,000 gross leaseable square feet in floor area	200 to 250 feet (about 15 car lengths)
Small commercial developments with signalized access driveways	80 to 90 feet (five to six car lengths)
Small commercial developments with unsignalized commercial driveways	30 to 50 feet (two to three car lengths)

Source: Florida Department of Transportation.

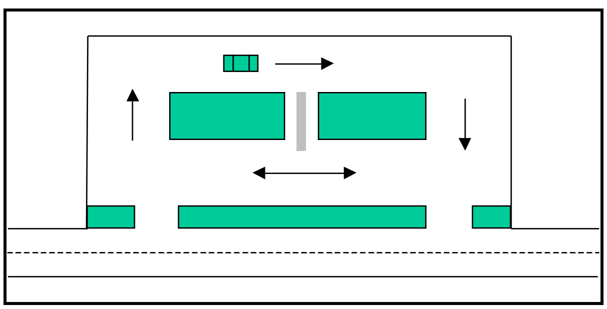
Inadequate driveway throat length is the number one problem that occurs when internal land development circulation is poorly designed. Note that, particularly in the last category of the table (small commercial developments with unsignalized driveways), short driveway throat lengths are quite common. Most commercial developments do not include a two to three car length driveway. This can lead to situations in which traffic circulation within the commercial development is chaotic. It can also lead to situations in which traffic turning into a development queues on the arterial roadway while waiting for vehicles to clear the short driveway. This is unsafe and may cause accidents.



Adequate throat length allows stacking, or queuing, to occur on site. This reduces driver confusion, traffic problems, and unsafe conditions.



Insufficient throat length and poor site planning can cause unsafe conditions and result in vehicles backing out onto the arterial, interrupting traffic flow.



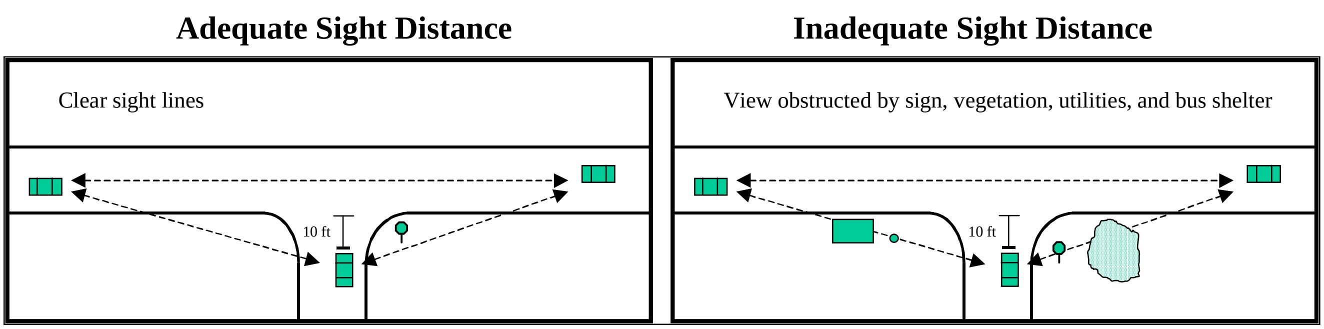
Complete on-site circulation and cross access between adjacent properties allow vehicles to travel between adjacent businesses without having to re-enter the arterial.

Are there issues that should be considered in conjunction with internal circulation?
Driveway throat length is closely related to the following access management subjects: driveway turn radius, driveway width, driveway grade, shared/joint driveways and/or cross access, driveway-related crashes, and speed differential between turning vehicles and through traffic.

Sight Distance

Guidelines for adequate sight distance are one of the most important and basic approaches a community can take in managing access to its roadways. Sight distance guidelines can help communities ensure that its arterials are safe for motorists and pedestrians. Sight distance guidelines can also help communities promote adequate spacing of residential and commercial driveways.

What is sight distance?
Sight distance is the length of highway visible to a driver. A safe sight distance is the distance needed by a driver on an arterial, or a driver exiting a driveway or street, to verify that the road is clear and avoid conflicts with other vehicles. Sight lines must be kept free of objects which might interfere with the ability of drivers to see other vehicles (see figure). Features such as hills, curves in the road, vegetation, other landscaping, signs, and buildings can reduce sight distance.



Why is sight distance important?
Sight distance is critical to motorists in making decisions such as to stop, slow down, turn, enter a traffic stream from a driveway or public road, or merge into traffic. Adequate sight distance allows motorists the time they need to avoid crashes and conflicts. Adequate sight distance will help keep roadways operating safely and smoothly.

What is a reasonable sight distance?
The safe sight distance for low and medium volume driveways should be large enough to allow vehicles on the arterial to slow down to a reasonable speed, but not stop, to avoid a collision with vehicles exiting a driveway. The safe sight distance for high volume driveways should be higher to allow a greater margin of safety. Stopping sight distance increases on downgrades and increases on upgrades.

The Iowa Departmetn of Transportation's sight distance policy is based upon the American Association of State Highway and Transportation Officials (AASHTO) stopping distance criteria and posted daytime speed limits for passenger cars. The following table shows desirable sight distances published in the AASHTO *Green Book* (1994, Table III-1).

Posted Daytime Speed Limit (mph)	**Desirable Sight Distance (feet)**	**Minimum Sight Distance (feet)**
55	725	450–500
50	650	400–475
45	550	325–400
40	475	275–325
35	400	225–250
30	325	200
25	250	150

What about in rural areas?
Sight distance at driveways and/or farm field entrances is especially critical in rural areas because travel speeds are high and curves or hilly terrain may restrict sight lines. Higher vehicle speeds mean that driver reaction and physical stopping distances are longer.

Example of inadequate sight distance as viewed from the driveway. The exiting driver cannot see far enough to safely enter the traffic stream. This situation presents an operational and safety concern.

Are there issues that should be considered in conjunction with sight distance?
Sight distance is closely related to the following access management subjects: driveway-related crashes, driveway spacing, driveway density and consolidation, access management and pedestrian safety, and utility placement and clear zones.

Incorporating Aesthetics into Access Management

Access management projects often involve widening existing roadways to add either an additional two-way-left-turn lane (TWLTL) or a raised median. Such projects can lead to a wide expanse of concrete and asphalt. An aesthetically pleasing treatment, however, does not need to run counter to sound access management practices. In fact, aesthetics can and should be incorporated into access management project plans.

Why are aesthetics important?
Access management projects are much more likely to be accepted by the public and by business owners of adjacent properties if they look good as well as improve safety and traffic flow.

What are some possible aesthetic treatments for access management projects?
In conjunction with access management improvements such as consolidating driveways, installing raised medians, or constructing TWLTLs, many aesthetic treatments are possible. These include

- landscaping the raised median
- adding pavement textures and designs to parking areas
- adding well designed retaining walls where needed to prevent erosion
- planting street trees and other vegetation *outside* the clear zone
- removing signs from the clear zone and otherwise modifying commercial signs to make them less obtrusive
- adding uniform, well designed street lights and other hardware
- placing utility lines underground to eliminate them from view and reduce the need for utility poles

Such aesthetic treatments can, when combined with access management, create a much more attractive roadway corridor that is also highly functional and safer.

See top photograph for an example of an access management project that incorporates aesthetic considerations (and the photograph below for contrast).

This access management project in Ankeny, Iowa, incorporates a number of positive aesthetic features, including a landscaped median with brick paving, utilities placed underground, street trees planted outside the clear zone, and unobtrusive business signs.

Contrast the Ankeny street (top) with a nearby corridor with no landscaping, numerous power poles and utility lines next to the street, and obtrusive business signs. Which corridor would you rather drive, walk, or own a business along?

Clear Zones, Utility Placement, and Lighting

Adequate clear zones with proper placement of utilities and sufficient lighting are essential components of well designed roadways. Proper design will help ensure sufficient sight distance and improve roadway operating safety.

What is a clear zone?
The American Association of State Highway and Transportation Officials (AASHTO) *Green Book* states that "a clear zone is used to designate the unobstructed, relatively flat area provided beyond the edge of the traveled way for the recovery of errant vehicles." Utilities, structures, signs, trees, and other objects should not be located within the clear zone.

How wide should the clear zone be?
The width of this clear zone is influenced by traffic volumes, speed, and embankment slopes. AASHTO's *Roadside Design Guide* can be used to determine appropriate clear zones for higher speed rural roads.

Because space for clear zones is generally restricted in urban areas, the Iowa Department of Transportation (Iowa DOT) recommends a minimum clear zone of 10 feet on reduced-speed urban arterials, with 12 feet desirable. The width of the clear zone is measured from the back of the curb. Where no reasonable alternative exists, the Iowa DOT allows above-ground utilities to be accommodated in the outermost 2-foot width of the right-of-way. Preferably, all objects should be located outside the minimum clear zone. If this placement is not practical, the Iowa DOT allows for "breakaway" objects, such as certain sign supports, within this area. In all cases, the edge of any object should be no closer than 1.5 feet to the back of the curb.

Wide clear zone with good lighting on 100th Street in Clive, Iowa. The sidewalk is well delineated, trees are located a good distance from the roadway, and utilities are underground.

Why are clear zones, utility placement, and lighting important?
Access management projects provide a good opportunity to improve clear zones and enhance roadside lighting (see photographs of Douglas Avenue). Attention to clear zones and lighting can reduce crashes and improve traffic flow by enhancing the visibility of other vehicles, pedestrians, and access points as well as provide a relatively safe space for vehicles that leave the roadway.

Proper design of clear zones and lighting can

- reduce roadway maintenance costs
- improve drainage
- provide space for snow removal
- assist in orderly roadside development
- delineate and protect pedestrian walkways
- delineate driveways and access points
- enhance roadside aesthetics
- reduce right-of-way requirements

Uniform, well designed streetlights and other hardware can be used to enhance roadside aesthetics and create a sense of community. Utility lines can be placed underground to eliminate them from view and reduce the need for utility poles. Signs can be removed from the clear zone and/or modified to make them less obtrusive. Landscaping can help delineate driveways, making it easier for motorists to locate driveway entry/exit points.

Wide clear zones on Douglas Avenue in Urbandale, Iowa. Utilities and fire hydrants have been set back a good distance from the roadway. Uniform, attractive lighting creates visual appeal.

Inadequate clear zones on Douglas/Euclid Avenue in Des Moines, Iowa. Utilities are located too close to the curb. Driveways and sidewalks, which have been blocked by snow and ice, are not well delineated.